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A New Momentum and Reversal under Prospect Theory: Introduction and Their Implications

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Abstract

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Based on the prospect theory value (TK value) by Barberis et al. (2014), I construct new "Short-term TK" by using the previous 12-month returns and "Extreme TK" by using only 20 extreme returns among 60-month historical returns. Although stocks with a high original TK generate low subsequent returns (reversal), stocks with high Short-term TK generate high subsequent returns (momentum). This new momentum is distinguished from price momentum, and helps to decompose the causes of price momentum into underreaction and delayed overreaction. Furthermore, Extreme TK persistently generates a larger reversal than the original TK. Also with more sophisticated analysis, I show that Extreme TK is a lottery proxy variable, whereas the original TK is not.

Keywords: Prospect theory, TK momentum, price momentum, return reversal, lottery-type stock

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Contents

Figures

Tables

1. Introduction

Prospect theory value, as suggested by Barberis, et al. (2014), is a new measure representing how investors allocate their assets based on past returns. Prospect theory value is also called "TK value," an acronym coined by Tversky and Kahneman (1992). According to their cumulative prospect theory, investors weigh the events of small probability more than actual probability. Then, under the assumption that some investors use a stock's historical return distribution as the expected return distribution of the stock, TK value computed by the stock's historical returns represents the stock's "value" as felt by the investors, from the perspective of the cumulative prospect theory. Thus, Barberis et al. (2014) suggest that when TK value of a stock is high, such stock appeals to investors, so investors overreact to the stock, leading to an overvaluation of the stock, which subsequently earns lower returns.[1]

DeBondt and Thaler (1985) suggest a contrarian strategy: when a portfolio is constructed by cumulative monthly returns over the previous 3 to 5 years, the reversal of subsequent returns is consistently observed. They argue that the phenomenon occurs due to overreaction, which is also the pivotal reason for the reversal in portfolios ranked by TK values. TK value is constructed by using historical 36- to 60-month returns. Although the ideas underlying both phenomena differ, they share the same "time period for

[1] In fact, this phenomenon is not the same as the reversal phenomenon. However, in the sense that people highly appreciate stocks that show low subsequent returns, I prefer at times to call this a reversal.

portfolio construction" and "overreaction story."

On the other hand, Jegadeesh and Titman (1993) suggest a price momentum strategy: when a portfolio is constructed by cumulative monthly returns over the previous 6 to 12 months, the momentum phenomenon is observed. Therefore, I construct "Short-term TK" value by using historical 12-month returns to see whether stock return behavior such as a momentum exists when portfolios are formed by ranking Short-term TK value. Long-short portfolio that buys stocks in the highest Short-term TK decile and shorts stocks in the lowest Short-term TK decile shows a new momentum phenomenon similar with price momentum,[2] so I call this new type of momentum, TK momentum. However, since the construction of TK momentum and JT momentum have different starting points, it is necessary to figure out any characteristics specific only to each type of momentum. Brief statistics show that TK value and JT value have a significantly high correlation, and about 70% of stocks in each winner/loser portfolio are identical. Nevertheless, various statistical tests prove that the two momentums are surely distinct. In particular, Fama-Macbeth (1973) cross-sectional regression verifies that TK value itself has a significant predictive power for future stock returns while JT value does not, when both variables are simultaneously included. Also by considering the subsets whose stocks are only in TK winner (loser), in JT winner (loser) and in the intersection of them,

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[2] I often use the term "JT momentum" to indicate price momentum as explained by Jegadeesh and Titman (1993). In addition, I call the cumulative returns from *t*-13 to *t*-2, "JT value," which is used to compute price momentum.

a comparison of cumulative momentum profits from the subsets guarantees that JT momentum is derived by both underreaction and delayed overreaction but TK momentum is derived only by delayed overreaction.

In fact, the causes of JT momentum have been debated. Mathematically, Lo and MacKinlay (1990) give an idea that momentum can be caused by autocorrelation in returns, cross-serial correlation among stocks, or cross-sectional variance of the mean returns. In addition, there are three representative theoretical studies on the behavioral explanation (underreaction or delayed overreaction): Barberis et al. (1998), Daniel et al. (1998), and Hong and Stein (1999). Barberis et al. (1998) suggest that investors initially underreact to news such as earnings announcements due to a conservatism bias, but eventually overreact to subsequent series of the news reports. After all, momentum is observed, followed by reversal. Daniel et al. (1998) insist that momentum occurs due to an overreaction from overconfidence and self-attribution bias. Hong and Stein (1999) state that momentum can be interpreted by considering two groups: news watchers and momentum traders. When news watchers react to any information, momentum appears to occur by initial underreaction. Then, as momentum traders overreact on the phenomenon, reversal eventually occurs at long-horizon.

In addition to the above literature, Grinblatt and Han (2005) say that momentum is, in part, caused by a disposition effect, and they support the logic by using the concept of capital gains overhang. Jegadeesh and Titman (2001) argue that JT momentum comes from delayed overreaction by looking at cumulative momentum profits over the 60-month period following the portfolio formation. If underreaction is the source of momentum, there should not appear a significant reversal during the post-holding period; if there is delayed overreaction, a significant reversal should exist. I analyze cumulative momentum profits to judge the causes of TK momentum and JT momentum. In particular, the finding that the causes of price momentum are explicitly decomposed into underreaction and delayed overreaction is meaningful in that the result gives a novel perspective to the causes of price momentum.

Since Jegadeesh and Titman (1993) introduced the concept of momentum phenomenon, the causes and different types of momentum strategies have been suggested and verified. For example, Chan et al. (1996) address that past earnings surprise also predicts a large drift in future returns, which is also called earnings momentum. Moskowitz and Grinblatt (1999) say that momentum is mainly caused by industry effect. George and Hwang (2004) introduce 52-week high momentum: by taking the highest price during the past 52 weeks as a reference price, all stocks are ranked by the ratio of current price to the highest price to classify winner and loser portfolios. Recently, Huehn and Scholz (2014) suggest that winner and loser portfolios sorted by the Fama-French 3-factor alpha (Fama and French, 1993) also generate momentum strategy. Likewise, TK momentum, which is based on investors' short-term stock value judgments under the cumulative prospect theory, can be also regarded as a different type of momentum.

However, to further support all the arguments about delayed overreaction to yield TK momentum, I examine whether TK momentum occurs through the price correction process when over- or underpriced stocks are corrected to intrinsic value. For the simplicity, I call the mechanism that TK momentum occurs through the price correction process "price correction story". As suggested by Hur and Singh (2014), the speed of price correction can be measured to reflect how fast mispricing is corrected. Thus, if TK momentum profit from the slowest speed group is significantly higher than that of the fastest speed group, the price correction story for TK momentum is confirmed. Bivariate sort analysis and cumulative return analysis verify the story.

In addition to Short-term TK, the second new type of TK value that I construct is Extreme TK. Its construction basically follows the construction of Long-term TK[3] by Barberis et al. (2014), but it reflects more reasonable and realistic circumstances. Showing that investors react more to historical returns that have larger magnitude in their investment decisions, I construct Extreme TK using only 20 months of returns with absolute values in the top 20 among returns from the previous 60 months. Long-short portfolio that buys stocks in the lowest Extreme TK decile and shorts stocks in the highest Extreme TK decile generates a larger reversal than long-short portfolio by Long-term TK.

Extreme TK has another finding that it is a more effective proxy of lottery demand than Long-term TK. Although Barberis et al. (2014) say that Long-term TK behaves like a lottery proxy, this is not rigorously verified. Brunnermeier et al. (2007) and Barberis and Huang (2008) describe the term "lottery-type" as "having positively skewed distribution." Conrad et al. (2014)

[3] From now on, I use the term Long-term TK to indicate the TK value, as originally suggested by Barberis et al. (2014).

state that firms with high default probability tend to have higher jackpot payoffs, a characteristic of lottery-type payoffs. A more delicate description by Kumar (2009) is that stocks with low price, high idiosyncratic volatility (IVOL) and high idiosyncratic skewness (ISKEW) are regarded as lottery-type stocks. Specifically, some variables are suggested to represent lottery proxy, and two of them are expected idiosyncratic skewness (EISKEW) by Boyer et al. (2010) and the maximum daily return over the past one month (MAX) by Bali et al. (2011). Thus, I observe whether high Long-term TK and Extreme TK portfolios satisfy the conditions of a lottery-type portfolio. However, I disregard the low price criterion, since the magnitude of an investment may be determined not largely by each stock's price, but by each investor's endowment. Then, decile portfolios sorted by Extreme TK or by Long-term TK show that while Long-term TK cannot be considered a lottery proxy, Extreme TK becomes a lottery proxy.

In Section 2 of this paper, I discuss the conceptual framework of TK value that is used in Barberis et al. (2014) and the related theory. In Section 3, the speed of price correction and derivation are introduced, as in Hur and Singh (2014). Section 4 provides data and variable definitions used in this paper. Section 5 shows the results of momentum analyses of Short-term TK. Section 6 examines the reversal and the lottery-related properties of Extreme TK, and Section 7 is the conclusion.

2. Prospect Theory Value

An assumption in Barberis et al. (2014) is that some investors allocate their stocks depending, in part, on the TK value of the stocks' historical return distributions. When the TK value of a stock is high, such stock appeals to investors, causing the stock to be overvalued, and subsequently leading to lower returns. To understand TK value, one must understand the cumulative prospect theory.

$$(x_{-m}, p_{-m}; \cdots; x_{-1}, p_{-1}; x_0, p_0; x_1, p_1; \cdots; x_n, p_n) \tag{1}$$

Expression (1) above is the conventional representation of a gamble in economics or finance. The expression is based on the order of the magnitude of possible gains or losses. Thus $x_i < x_j$ for $i < j$ and $x_0 = 0$. The negative sign in the subscript represents the negative outcome. Then, investors assign their preferences based on the combination of the specific value function and the weighting function, as suggested by Tversky and Kahneman (1992).

$$v(x) = \begin{cases} x^{\alpha} & \text{for } \ x \geq 0 \\ -\lambda(-x)^{\alpha} & \text{for } \ x < 0 \end{cases} \tag{2}$$

$$w^{+}(P) = \frac{P^{\gamma}}{(P^{\gamma} + (1-P)^{\gamma})^{1/\gamma}}, \quad w^{-}(P) = \frac{P^{\delta}}{(P^{\delta} + (1-P)^{\delta})^{1/\delta}} \tag{3}$$

$$\pi_i = \begin{cases} w^{+}(p_i + \cdots + p_n) - w^{+}(p_{i+1} + \cdots + p_n) & \text{for } \quad 0 \leq i \leq n \\ w^{-}(p_{-m} + \cdots + p_i) - w^{-}(p_{-m} + \cdots + p_{i-1}) & \text{for } \ -m \leq i < 0 \end{cases} \tag{4}$$

Expression (2) represents the value function and (3) represents the weighting function where $\alpha, \gamma, \delta \in (0, 1)$ and $\lambda > 1$. According to Tversky and Kahneman (1992), it is reasonable to set $\alpha = 0.88, \lambda = 2.25, \gamma = 0.61,$ and $\delta = 0.69$. Different from the traditional utility function, value function implies that preference function for the loss should be convex, and the absolute value of concavity in the loss region is much larger than that of the gain region. Weighting function implies that investors exaggerate the probability of an event if its actual probability is relatively small.

In the cumulative prospect theory, not only small probability but also extreme events (for example, the highest or lowest event in a given gamble) are weighted more than other events. This is illustrated by expression (4). Then, as in the expected utility framework, investors' preferences can be measured under the cumulative prospect theory. This value is described in Expression (5), as follows.

$$\sum_{i=-m}^{n} \pi_i v(x_i) \tag{5}$$

The basic underlying assumption of prospect theory value is that people consider the past return distributions of stocks for their investment decisions.[4] However, cumulative prospect theory itself does not show how investors consider past return distributions in their investing. Thus, it is

[4] Both Short-term and Long-term TK values are computed in this paper, but here, TK value explanation is based on the Long-term case. In the Short-term case, 12 months are used instead of 60 months.

assumed that a stock's historical return distribution is as follows:

$$(r_{-m}, \frac{1}{60}; \cdots; r_{-1}, \frac{1}{60}; r_1, \frac{1}{60}; \cdots; r_n, \frac{1}{60}) \tag{6}$$

This is the direct result from Expression (1), with equal probabilities for 60 cases, each of which is the monthly return from the prior 5 years (60 months). In this expression, m is the number of negative monthly returns and n is the number of positive monthly returns in the given period. Then, applying Equation (5) directly yields the TK value.

$$\begin{aligned} TK = \sum_{i=-m}^{-1} v(r_i) \left[w^- \left(\frac{i+m+1}{60} \right) - w^- \left(\frac{j+m}{60} \right) \right] \\ + \sum_{i=1}^{n} v(r_i) \left[w^+ \left(\frac{n-i+1}{60} \right) - w^+ \left(\frac{n-i}{60} \right) \right] \end{aligned} \tag{7}$$

Furthermore, although Barberis et al. (2014) supported their arguments by providing a theoretical model, they did not provide any information on "the time period for TK value construction" and "the time interval between the construction of TK value and the beginning of the reversal". The given model is described by Expression (8).

$$\frac{\mu_j - r}{\mu_m - r} = \beta_j - \frac{\eta \omega_{TK}^j s_j^2}{\sigma_m^2 (1 - \eta \beta_{TK})} \tag{8}$$

where β_j and β_{TK} are estimated from

$$\tilde{r}_j = r_f + \beta_j (\tilde{r}_m - r_f) + \tilde{\epsilon}_j \tag{9}$$

$$\tilde{r}_{TK} = r_f + \beta_{TK}(\tilde{r}_m - r_f) + \tilde{\epsilon}_{TK} \tag{10}$$

and η is the fraction of investors who rely on TK value, s_j^2 is the variance of $\tilde{\epsilon}_j$, and ω_{TK}^j is the weight of stock j in the TK portfolio. From Equation (8), when a stock j has a higher TK value than a previous period, ω_{TK}^j is higher because TK investors consider the stocks optimistically. Then, if all other parts remain unchanged, the alpha becomes lower, which implies a reversal. However, it does not give any information on "time period for TK value construction" and "the time interval between the construction of TK value and the beginning of the reversal". The model does not substantiate that the reversal occurs right after the TK portfolio formation. Instead, reversal can appear after several months and it is possible that momentum persists during the first few months after the TK portfolio formation. This phenomenon can be affected by a different time period for TK value construction. Hence, the idea of TK momentum does not counter the theoretical model by Barberis et al. (2014).

3. Speed of Price Correction

If momentum is caused by underreaction or delayed overreaction, then pricing errors in winner and loser portfolios should exist, leading to price correction to alleviate the pricing errors. If it is possible to measure the speed of the price correction, the following hypothesis can be tested. When the speed of price correction is slower, it would take more time for the mispricing to be corrected, so the momentum would continue longer. The speed of price correction is measured as in Hur and Singh (2014).

$$p_{it} = \ln(P_{it}) - \ln(B_t) \tag{11}$$

$$m_t = \ln(M_t) - \ln(B_t) \tag{12}$$

$$p_{it} = a_i + \theta_i m_t + \epsilon_{it} \tag{13}$$

$$\Delta p_{it} = \hat{\theta}_i \Delta m_t + \lambda_i \left(p_{i,t-1} - \hat{a}_i - \hat{\theta}_i m_{t-1}\right) + \nu_{it} \tag{14}$$

where P_{it} is the market price of stock i, the price of treasury bill $B_t = \frac{1}{1+r_{Tbill_{30d}}}$, and M_t is the level of the value-weighted market index. First, I obtain p_{it} and m_t using (11) and (12), then run the regression of market model (13) to find the corresponding coefficients for each stock i. In the regression, I use the previous 12 months of returns from *t*-13 to *t*-2 for each a_i and θ_i at each time *t*. Since it is a rolling regression, the time subscript of a_i and θ_i is not represented in (13) and (14), to eliminate any confusion. Again, using the previous 12-month returns as in (13), I run the regression of the model (14) to find the speed of price correction λ_i for each stock i at time *t*. By looking at the models (13) and (14), $p_{i,t-1} - \hat{a}_i - \hat{\theta}_i m_{t-1}$ is the pricing error at time *t*-1. The coefficient λ_i thus denotes the sensitivity between the pricing error at time *t*-1 and the change of price from time *t*-1 to time *t*, so that it becomes the speed of price correction for each stock i at time *t*.

Note that when a price is overvalued at time *t*-1, it would be lowered at time *t*. Since overvaluation induces $p_{i,t-1} - \hat{a}_i - \hat{\theta}_i m_{t-1} > 0$ and $\Delta p_{it} < 0$, λ_i is expected to be negative. Here, when the absolute value of λ_i is smaller, the speed of price correction is slower.

4. Data and Variables

This study includes all common (ordinary) stocks that are traded or were once traded on the New York Stock Exchange (NYSE), American Stock Exchange (AMEX), and Nasdaq of the American stock market. All data sets are obtained from CRSP and COMPUSTAT. In this paper, data samples used in Short-term and Extreme TK value analyses are different because of their constructions. In the case of Short-term TK analyses, since both CRSP and COMPUSTAT data should exist simultaneously, previous 13-month data should exist[5], and time lag occurs in the construction of Book-to-Market following Fama and French (1992); full sample period for the analyses becomes August 1964 to December 2014. At the beginning of the holding period, I exclude all stocks priced below $5 and stocks whose market capitalizations are in the smallest decile range of NYSE stocks. These stocks are excluded to ensure that any results obtained in this paper were not particularly from small and illiquid stocks. For the case of Extreme TK analyses, the basic setting follows Barberis et al. (2014), Bali et al. (2011), and Boyer et al. (2010), and the variables in these studies are simultaneously considered. Therefore, data sampling is similar to the case of Short-term TK analyses, except that previous 60-month data should exist and only stocks priced below $5 are excluded at the beginning of the holding period. Then, the full analysis period

[5] Previous 12-month data should exist for the calculation of Short-term TK, and 1-month skip between portfolio formation and the holding period is needed due to the bid-ask bounce problem.

becomes July 1968 to December 2014. Moreover, I further exclude financial firms, whose two-digit-SIC codes are from 60 to 69, following Moskowitz and Grinblatt (1999). 30-day Treasury bill rates are used for the risk-free rates, and the value-weighted return of NYSE, AMEX and Nasdaq is used for the market return.

[Table 1 about here]

Table 1 reports the summary statistics of variables used in this paper. Panel A documents the means, medians, maximums, minimums and standard deviations, while Panel B documents correlations of the variables. All statistics are computed by monthly cross-section and then reported by the time-series average of monthly cross-sectional statistics. All variables shown in the Table 1 are constructed as the following:

- Short-term TK: Prospect theory value computed by Equation (7) using the monthly data from the start of month t-13 to the end of month t-2 (Barberis et al., 2014)
- Long-term TK: Prospect theory value computed by Equation (7) using the monthly data from the start of month t-60 to the end of month t-1 (Barberis et al., 2014)
- Extreme TK: Prospect theory value computed using 20 monthly returns with absolute values that are in the top 20 of the previous 60-month returns from t-60 to t-1 (Barberis et al., 2014)

- Size: Log market capitalization (unit: one thousand dollars) at the end of the previous month (Fama and French, 1992)
- BEME: Log book-to-market ratio (Fama and French, 1992)
- JT: Cumulative monthly return of a stock from the start of month *t*-13 to the end of month *t*-2 (Jegadeesh and Titman, 1993)
- MAX: Maximum daily return during the previous one month (Bali et al., 2011)
- IVOL: Idiosyncratic volatility over the previous 60 months from *t*-60 to *t*-1 using monthly data (Ang et al., 2006)

$$r_{i,\tau} - r_{f,\tau} = \alpha_i + \beta_i MKT_\tau + s_i SMB_\tau + h_i HML_\tau + \epsilon_{i,\tau} \tag{15}$$

$$IVOL_{i,t} = \sqrt{var(\epsilon_{i,\tau})} \tag{16}$$

- ISKEW: Idiosyncratic skewness over the previous 60 months from *t*-60 to *t*-1 using monthly data, where $S(t)$ is the set of trading months and $N(t)$ is the number of months minus a degree of freedom

$$ISKEW_{i,t} = \frac{1}{N(t)} \frac{\sum_{\tau \in S(t)} \epsilon_{i,\tau}^3}{\left(IVOL_{i,t}\right)^3} \tag{17}$$

- EISKEW: the expected idiosyncratic return skewness for T=60, where all variables exactly follow Boyer et al. (2010)[6]

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[6] $ISKEW_{i,t}$ and $IVOL_{i,t}$ follow the same definitions with those in this paper. $JT_{i,t}$ is the cumulative monthly return from *t*-12 to *t*-1. $Turn_{i,t}$ is the average daily return over month t. $SDum_{i,t}$ and $MDum_{i,t}$ are small and medium size dummy variables when all stocks are equally grouped into small, medium, and big stocks. $NasdaqDum_{i,t}$ is the dummy variable such that it has a value of 1 if a stock *i* is traded in Nasdaq. $IndDum_{i,t}^k$ is the industry dummy

$$
\begin{aligned}
ISKEW_{i,t} = \beta_{0,t} + \beta_{1,t} ISKEW_{i,t-T} + \beta_{2,t} IVOL_{i,t-T} + \lambda_{1,t} JT_{i,t-T} \\
+ \lambda_{2,t} Turn_{i,t-T} + \lambda_{3,t} SDum_{i,t-T} + \lambda_{4,t} MDum_{i,t-T} \\
+ \lambda_{5,t} NasdaqDum_{i,t-T} + \sum_{k=1}^{K} \delta_{k,t} IndDum_{i,t-T}^{k} + \epsilon_{i,t}
\end{aligned} \tag{18}
$$

$$
\begin{aligned}
E_t\left[ISKEW_{i,t+T}\right] = \hat{\beta}_{0,t} + \hat{\beta}_{1,t} ISKEW_{i,t} + \hat{\beta}_{2,t} IVOL_{i,t} + \hat{\lambda}_{1,t} JT_{i,t} \\
+ \hat{\lambda}_{2,t} Turn_{i,t} + \hat{\lambda}_{3,t} SDum_{i,t} + \hat{\lambda}_{4,t} MDum_{i,t} \\
+ \hat{\lambda}_{5,t} NasdaqDum_{i,t} + \sum_{k=1}^{K} \hat{\delta}_{k,t} IndDum_{i,t}^{k}
\end{aligned} \tag{19}
$$

- Turnover: Ratio of monthly trading volume to the number of shares outstanding at the end of month *t*
- Speed: Speed of price correction obtained from the regression (14) using the monthly data from *t*-13 to *t*-2 (Hur and Singh,2014)

As seen in Table 1, the Speed variable has a negative sign, as expected in Section 3. In Panel B, the most noticeable point is that Short-term TK and JT have a considerably high correlation as 0.874. It seems that two variables are too much similar to distinguish each other. Therefore, further analyses to compare TK momentum and JT momentum are necessary, and these are shown in the Section 5.2. If other correlations are also considered, Short-term TK and JT have different characteristics. Short-term TK is

variable based on two-digit SIC code. Moreover, Brian Boyer's website provides EISKEW data from July 1969 to December 2011. In this paper, I use the data, and thus analysis period becomes July 1969 to December 2011 when EISKEW is considered together.

positively correlated with size, but JT is negatively correlated with size. Another high correlation occurs between Long-term TK and Extreme TK. This is natural in that extreme return values which are used in the calculation of Extreme TK dominate in the computation of Long-term TK. Finally, though very small, Speed is negatively correlated with all types of TK values and JT.

5. Short-term TK Analyses Results

5.1 TK Momentum and JT Momentum Strategies

All stocks are classified by Short-term TK value or JT value to form decile portfolios. Momentum strategy derived by each Short-term TK and JT is the long-short strategy that buys winner (the 10^{th} decile) and shorts loser (the 1^{st} decile). All reported returns have a unit of percent (%) and full analysis period is from 08/1964 to 12/2014. However, Hwang and Rubesam (2015) state that high-tech and telecom stock bubbles made the momentum disappear after around the year 2000. Also Barroso and Santa-Clara (2015) say that a momentum crash occurred during the financial crisis in 2008. Three additional sub periods are considered: 08/1964 to 12/1999, 01/2000 to 12/2009, and 01/2010 to 12/2014. I call these sub periods as the 1^{st}, the 2^{nd}, and the 3^{rd} period, respectively.

[Table 2 about here]

Table 2 represents the monthly returns of a WML (winner – loser) portfolio after portfolio formation. Specifically, monthly returns of TK WML and JT WML from t to t+11 are reported. As the table clearly shows, TK WML persists positively for about six months and JT WML persists positively for about seven months. In the 1^{st} sub period, both two WMLs persisted longer, but in the 2^{nd} sub period, there are no positive returns from the WMLs. In the 3^{rd} sub period, both TK and JT WMLs show positive returns for all 12 months, but there is little monotonicity of returns as time passed by. Overall, TK and JT WMLs are similarly show persistent positive returns.

Furthermore, as Jegadeesh and Titman (1993) first suggest, J/K method is used to compute a momentum profit. In this paper, J=12/K=6 strategy is applied because Short-term TK and JT are constructed by using the previous 12-month returns. From now on, not only sub period analyses but also January effect analyses (January Included and January Excluded) are conducted together. In Table 3, basically raw return of each decile portfolio is reported, and WML is calculated as the raw return of winner minus that of loser at each month. In addition to that, Fama-French 5-factor alpha of WML is computed following Fama and French (2015).

[Table 3 about here]

Table 3 shows the profits from J/K strategies for the portfolios classified by Short-term TK or JT and for their WMLs. Representatively, full period results show that both TK and JT strategies' returns[7] increase monotonically from P1 (loser) to P10 (winner). Hence WMLs are significantly positive, and when January is excluded, the magnitudes of returns and significances increase. In TK strategy, WML is 0.48% and WML with January-excluded is 0.71% per month. Other sub periods analyses show similar results with Table 2. Moreover, Fama-French 5-factor alphas of WML

[7] TK strategy indicates J/K strategies for the portfolios classified by Short-term TK

represent same pattern with the raw returns of WML. However, for the case of full period and 1st sub period, the magnitudes and the significances of alphas are much higher than those of returns.

To sum up, Table 2 and Table 3 verify that TK momentum exists, and its magnitude and significance are similar with those of JT momentum. However, results of TK strategy and JT strategy are very close each other. One might think that two strategies are almost same because Short-term TK and JT are highly correlated as represented in Table 1. Nonetheless, the next section shows the differences between the two.

5.2 Comparison between TK Momentum and JT Momentum

To deeply examine the commonalities between Short-term TK winner (loser) and JT winner (loser) stock, I define the concept of similarity between TK strategy and JT strategy as the ratio of the number of stocks that are both in Short-term TK and JT winner (loser) portfolios to the total number of stocks in any winner (loser) portfolios at each time *t*.

[Figure 1 about here]

Figure 1 describes the similarity between portfolios constructed by Short-term TK and JT winner/loser at each time *t*. Panel A represents a winner portfolio and Panel B represents a loser portfolio. Exact time-series average value of each panel is not documented in the figure, but average similarity of the winner is 0.662 and that of the loser is 0.744. Thus, the Short-term TK and JT winner/loser categories share around 70% of stocks in common. This ratio is large enough to say that those 70% stocks may be the main sources of the momentums in TK and JT strategies. However, the following test results confirm that the two strategies have different properties.

[Table 4 about here]

Table 4 documents the momentum profits from different subsets: TK Only, JT Only, and TK ∩ JT. The TK Only subset consists of stocks that are only in Short-term TK winner or loser. The JT Only subset analogously consists of stocks that are only in JT winner or loser. Finally, the TK ∩ JT subset consists of stocks that are both in the Short-term TK and JT winner/loser categories. Due to the small sample problem in TK Only and JT Only subsets, quintile rather than decile portfolios are formed to analyze momentum strategies. WMLs are computed for each subset. Also, different from previous sub periods testing, only the 1st and the 3rd sub periods were analyzed. In the full period, the TK Only subset shows a significantly positive WML return of 0.34% only if January is excluded, while the JT Only subset shows insignificant results. As expected, the TK ∩ JT subset shows highly significant and positive abnormal WML returns. Even though the JT Only subset has significantly positive WML returns in the 1st sub period (regardless of the inclusion of January), they still represent about half of the WML returns from the TK ∩ JT subset. Therefore, the stocks that mainly cause JT momentum are from the TK ∩ JT subset. This implies that, under the cumulative prospect theory, the overvalued stocks in JT winner portfolio generate higher momentum. Also, Short-term TK generates its own momentum.

[Figure 2 about here]

Using the same subsets discussed in Table 4, Figure 2 illustrates the cumulative momentum profits of different subsets over 60 months (from *t* to *t*+59) following the portfolio formation at the end of month *t*-2. Figure 2 provides two meaningful results. First, the TK Only subset and JT Only subset show different movements of cumulative momentum profits as time passed by. In particular, WML from the TK Only subset shows a temporary momentum and then a reversal. WML from the JT Only subset also shows a temporary momentum without a subsequent reversal. Therefore, the two momentums are distinct in terms of long-term observation. Furthermore, as stated by Jegadeesh and Titman (2001), if momentum is derived by underreaction, WML should not be reversed. If it is derived by delayed overreaction, WML should be reversed. As expected, WML from the TK Only subset as well as the TK ∩ JT subset shows a reversal, which is consistent with the mechanism of reversal of long-short portfolio by Long-term TK by Barberis et al. (2014). However, WML from the JT Only subset is not reversed. Thus, It can be concluded that there are two factors causing JT momentum: underreaction (verified by the JT Only subset) and delayed overreaction (verified by the TK ∩ JT subset).

[Table 5 about here]

[Figure 3 about here]

However, Barberis et al. (2014) argue that the overvaluation of high TK stock primarily occurs in small-size stocks. Although Short-term TK construction is different from Long-term TK, it could be sufficiently possible that the phenomenon of initial momentum and eventual reversal of Short-term TK is affected by small-size stocks. To consider the effects of size, Table 5 and Figure 3 show results analogous to Table 4 and Figure 2, except that size is controlled. Since controlling size reduces the number of samples in each portfolio, I divide size group into only small and big with respect to the median value at each month. Also, a tercile portfolio rather than quintile portfolio to construct winner and loser portfolios is used. Panel A of Table 5 represents mean and standard deviation of size in each subset: TK Only, JT Only, and TK ∩ JT. A noticeable point is that JT Only stocks in the winner portfolio have smaller size than those in the loser portfolio, whereas TK Only stocks and TK ∩ JT stocks show the reversed trend. Moreover, through Panel B and Panel C, small size stocks and big size stocks are respectively analyzed. Subset JT Only does not have significantly positive WMLs in any cases. Subset TK Only shows significantly positive WML return 0.36% in small size sample, when January is excluded. However, the TK ∩ JT subset still yields significantly positive WMLs in both small and large size samples. Hence, momentum from the TK Only subset is affected by size, but the momentum in subset TK ∩ JT is not affected by size. Figure 3 also describes the results of cumulative momentum profits of different subset strategies after size is controlled. Regardless of size, the TK Only subset and the TK ∩ JT subset show temporary momentums and then reversals, whereas the JT Only subset does not show a reversal after a temporary momentum. Therefore, the results shown in Figure 3 correspond to the results shown in Figure 2.

In addition to long-short portfolio analyses by sorting stocks, cross-sectional regression supports the argument that TK momentum dominates JT momentum in terms of stock return predictability. The following regression (20) refers to George and Hwang (2004) and Huehn and Scholz (2014), and it is fundamentally Fama-Macbeth (1973) regression.

$$\begin{aligned} R_{it} &= b_{0jt} + b_{1jt}R_{i,t-1} + b_{2jt}Size_{i,t-1} + b_{3jt}TKW_{i,t-j} \\ &\quad + b_{4jt}TKL_{i,t-j} + b_{5jt}JTW_{i,t-j} + b_{6jt}JTL_{i,t-j} + e_{it} \end{aligned} \tag{20}$$

Due to the one-month skip between the portfolio formation and holding periods to alleviate the impact of bid-ask bounce, the return of stock i at time t-1 should be controlled, as in $R_{i,t-1}$. Also, the log market capitalization of stock i at time t-1 should be controlled, as in $Size_{i,t-1}$. Then, to see the pure effects of each TK and JT winner/loser, consider the following four dummy variables: $TKW_{i,t-j}$ has the value of 1 if the stock i is in the TK winner portfolio at time t-j, and other variables $TKL_{i,t-j}$, $JTW_{i,t-j}$, $JTL_{i,t-j}$ are analogously constructed corresponding to TK loser, JT winner, and JT loser, respectively. In this cross-sectional regression, $j = 2, \cdots, 7$ are separately tested, due to the six-month holding period in the J=12/K=6 strategy, to obtain coefficients monthly. Each month, obtained coefficients for all six j's are averaged to represent the coefficients in the month. Then, the coefficients of $TKW - TKL$ and $JTW - JTL$ correspond to pure abnormal returns from TK momentum and JT momentum strategies, respectively. Not only raw returns, but also risk-adjusted returns using the Carhart 4-factor (Carhart, 1997) and the Fama-French 5-factor (Fama and French, 2015) are analyzed. Risk-adjusted returns are obtained by a time-series regression of the coefficients, computed from cross-sectional regressions of raw returns at each month *t*, on contemporaneous factors.

[Table 6 about here]

Table 6 shows that TK momentum dominates JT momentum, especially in the case of raw returns and risk-adjusted returns by FFC4-factor. For example, in the January-excluded sample, pure TK momentum has a profit 0.40% a month with a significance of less than 1%, whereas pure JT momentum has an insignificant positive profit of 0.18% a month. Using the same sample, pure TK momentum has a significant FFC4-factor alpha 0.18% whereas pure JT momentum has a negative FFC4-factor alpha -0.24%. However, it is hard to differentiate FF5-factor alphas between pure TK momentum and pure JT momentum, as both alphas were significantly positive. Not only full-period analysis but also sub periods analyses show consistent results. Overall, TK momentum has a better predictive power for stock returns than JT momentum. This result corresponds with the implications derived from Table 4 and Figure 2.

[Table 7 about here]

Table 7 represents the bivariate dependent sort analyses with TK and JT momentums. Particularly, the left side of the table shows TK WMLs after JT is controlled. The right side of the table shows JT WMLs after TK is controlled. In these analyses, 5×5 portfolios are formed. Although Table 6 provides information about the dominance of TK momentum over JT momentum, Table 7 does not bolster the dominance. The results of the full period and sub periods are slightly different from each other, but overall, TK momentum is alive only in the loser or winner quintile of JT, and JT momentum is also alive only in the loser or winner quintile of Short-term TK. Thus, it is not substantiated that TK momentum dominates JT momentum. However, it can be still said that the two momentums are clearly distinct.

5.3 Speed of Price Correction and TK Momentum

The speed of price correction of each stock is computed through (11) to (14). To guarantee the price correction story to explain TK momentum, whether stocks with slower speed represent more persistent momentum is tested. With the panel data of the speed of price correction, quintile portfolios are first formed by the ranks of the variable Speed at each time *t*. Then, in each quintile, I reconstruct winner and loser portfolios by making quintile portfolios based on Short-term TK values to see the TK momentum effect in each Speed quintile.

[Figure 4 about here]

Figure 4 describes the cumulative TK momentum profits in Speed1, Speed3 and Speed5 over the 60 months (from t to t+59) after the portfolio formation at the end of the month t-2. Speed1, Speed3, and Speed5 represent the first (fastest), third, and fifth (slowest) Speed quintile portfolio, respectively, analyzed over the full period (08/1964 to 12/2014). Figure 4 clearly shows that TK momentum exists much stronger and much longer in the sample of Speed5, which supports the hypothesis: when the speed of price correction is slower, it would take more time for the mispricing to be corrected, so the momentum would continue longer.

[Table 8 about here]

Moreover, bivariate dependent sort analysis in Table 8 bolsters the hypothesis, in addition to the results covered in Figure 4. This table shows a relationship between the speed of price correction and TK momentum, measured by J=12/K=6 strategy. WML returns increased monotonically from 0.20% to 0.62% as the Speed was slower, and only the 4th and the 5th Speed quintiles (the slowest two Speed quintiles) showed significantly positive returns. Since the results in Figure 4 and Table 8 verify the price correction story to explain TK momentum, parts of the results discussed in the Section 5.1 and 5.2 become meaningful to demonstrate that the delayed overreaction of investors causes consistent TK momentum.

6. Extreme TK Analyses Results

Through Short-term TK, a momentum phenomenon and its properties were observed. In this section, Extreme TK is introduced and justified that Extreme TK is better and more reasonable variable to show investors' trading decision than Long-term TK.

[Table 9 about here]

I define #Extreme (n%) as the number of monthly returns whose absolute values are greater than or equal to n%, over the previous 60 months, used to justify the construction of Extreme TK. Panel A of Table 9 shows the monthly turnover of decile portfolios by #Extreme (5%) and #Extreme (10%), denoted by Turnover (5%) and Turnover (10%), respectively. This verifies that turnover monotonically increases as #Extreme (n%) increases, and Turnover (n%) of P10 is significantly greater than that of P1 in both n=5 and n=10. Therefore, it is justified that investors absolutely focus more on extreme-value returns.

Although the summary statistics of #Extreme (5%) and #Extreme (10%) are not reported here, the means of #Extreme (5%) and #Extreme (10%) are 33.6 and 17.4. Based on these numbers, the variable Extreme TK is constructed by using only 20 monthly returns with absolute values in top 20 among the previous 60 months of returns. Moreover, to investigate the lottery characteristics of Long-term TK and Extreme TK, well-known lottery proxy variables such as MAX and EISKEW are simultaneously considered. Panel B of Table 9 shows the returns of decile portfolios by candidates of lottery proxy: Long-term TK, Extreme TK, MAX, and EISKEW. Except MAX, other variables are constructed by using data from *t*-60 to *t*-1, and the returns at time *t* are evaluated. The profit of the long-short portfolio by Extreme TK is 0.04% higher than that the Long-term TK. However, the profits of long-short portfolios by MAX or EISKEW are much higher than those of Extreme TK or Long-term TK. Here, the lottery proxy whose 1-month long-short portfolio shows the strongest reversal is EISKEW.

[Figure 5 about here]

Figure 5 represents the holding period returns of long-short portfolios by lottery proxy candidates over 12 months. To compare them under the same condition, only the period from 07/1969 to 12/2011 is analyzed because I use EISKEW data for the period. The figure shows a big difference between Long-term TK/Extreme TK and MAX/EISKEW. The long-short portfolio holding period returns of Long-term TK or Extreme TK persistently increased, while those of MAX or EISKEW persistently decreased. Combining Figure 5 with Table 9, the reversals of high Long-term TK and Extreme TK persisted for at least 12 months, but those of high MAX and EISKEW disappeared. Furthermore, the reversal derived by Extreme TK is clearly larger than the reversal derived by Long-term TK.

The lottery characteristics of Long-term TK and Extreme TK are also examined. As Kumar (2009) states, lottery-type stock has a property of low price, high IVOL and high ISKEW. Kumar (2009) considers low stock price because lotteries are precisely from cheap bets. However, a stock's return does not generally depend on its price. If investors search for a jackpot return, lottery-type stock might not be necessary to satisfy low price but focus on the magnitude of return itself. Thus, I concentrate on IVOL and ISKEW to judge whether a variable can be a lottery proxy.

[Table 10 about here]

In each panel of Table 10, decile portfolios by Long-term TK, Extreme TK, MAX, or EISKEW are formed, and then the price, IVOL and ISKEW values of each decile portfolio are reported. Price of each stock at month t is the price at the end of month t-1. IVOL and ISKEW follows the definition stated in the Section 4. Panel C and Panel D show the lottery characteristics of well-known lottery proxies MAX and EISKEW. They have tendencies of monotonically increasing IVOL and ISKEW along with decreasing stock price as MAX and EISKEW increases. In addition, except for the low price, the high Extreme TK portfolio satisfies high IVOL and high ISKEW, whereas the high Long-term TK portfolio only satisfies high ISKEW. As a result, Table 10 verifies that Extreme TK, rather than Long-term TK, is a more appropriate lottery proxy variable. In addition to the results of Table 10, the results presented in Table 9 and Figure 5 also support the appropriateness of using Extreme TK as a lottery proxy variable. This is because Extreme TK persistently shows higher long-short portfolio profit than Long-term TK, and the reversal is one of the most important characteristic of lottery-type stocks.

[Table 11 about here]

Finally, Table 11 shows the results of bivariate sort analyses with Extreme TK and MAX (or EISKEW). The left (right) side of Panel A shows the analysis by constructing quintile portfolios by Extreme TK (MAX) and then dividing each quintile portfolio by MAX (Extreme TK). The same results using EISKEW instead of MAX are represented in Panel B. When Extreme TK is controlled, the profits of long-short portfolios by MAX are significantly positive only in the 1st and 5th Extreme TK quintiles. On the other hand, when MAX is controlled, the profits of long-short portfolios by Extreme TK are significantly positive only in the 3rd, 4th and 5th MAX quintiles. Moreover, when Extreme TK is controlled, the profits of long-short portfolios by EISKEW are significantly positive in all but 4th Extreme TK quintiles. When EISKEW is controlled, the profit of long-short portfolio by Extreme TK is significantly positive only in the 4th EISKEW quintile. Ultimately, Panel A implies that there is no dominance between Extreme TK and MAX. However, Panel B implies that EISKEW dominates Extreme TK. Therefore, Extreme TK may not be the best lottery proxy among the candidates, if it even can be called a lottery proxy.

7. Conclusion

Barberis et al. (2014) suggest using prospect theory value (referred to as Long-term TK in this paper) to test whether investors evaluate stocks according to the cumulative prospect theory. Since Long-term TK assumes that investors refer to previous 60-month returns to set the expected distribution of each stock's returns, I use the prior 12-month returns to construct Short-term TK. The reason I construct Short-term TK is that investors might consider short-term historical returns in their investment decision. Furthermore, investors focus, on average, more on extreme returns, not small returns, although they refer to previous 60-month returns. Thus, I use 20 extreme returns among the 60 previous monthly returns in constructing Extreme TK to reflect a more realistic environment.

Short-term TK provides two contributions. The first is that a new type of momentum is generated when a winner is defined as a portfolio with high Short-term TK and a loser is defined as a portfolio with low Short-term TK. Then, TK momentum is clearly distinguished from price momentum. The second is that the causes of price momentum are explicitly decomposed into underreaction and delayed overreaction through the comparison between TK and price momentums. Also, TK momentum is derived by delayed overreaction.

Finally, Extreme TK also provides two contributions. A Long-short portfolio by Extreme TK generates a larger reversal than Long-term TK. Moreover, Extreme TK becomes a lottery proxy variable, whereas Long-term

TK does not. However, there still remains more sophisticated justification of eliminating low price condition among the characteristics of a lottery proxy variable. Although I provide an intuition for the justification, delicate explanation with explicit evidences is necessary to conclude the argument: Extreme TK behaves as a lottery proxy variable.

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국문초록

전망이론에 기반한 새로운 주식수익률 모멘텀과 역전현상 제시 및 의미분석

본 논문은 Barberis et al. (2014)에서 제시된 전망이론값(TK)에 기반하여 "단기 TK (Short-term TK)"와 "극단 TK (Extreme TK)" 두 값을 새롭게 제시한다. 단기 TK 는 과거 12 개월 수익률을 이용하여 계산하며, 극단 TK 는 과거 60 개월 수익률 중, 절대값이 큰 20 개만 취하여 계산한다. 기존의 TK 로 구성한 헤지 포트폴리오는 평균적으로 주식수익률 역전 현상을 보였지만, 단기 TK 헤지 포트폴리오는 평균적으로 모멘텀 현상을 보인다. 이 모멘텀은 기존의 가격 모멘텀과는 다른 새로운 모멘텀이며, 이는 가격 모멘텀의 원인을 과소반응과 지연된 과대반응 두 가지로 구분시켜준다. 극단 TK 헤지 포트폴리오는 평균적으로 수익률 역전 현상을 보이며, 기존의 TK 보다 더 큰 수익률 역전을 일으킨다. 또한 극단 TK 는 복권성향 주식을 나타내기 위한 대용변수로 사용될 수 있지만 TK 는 그렇지 않음을 알 수 있다.

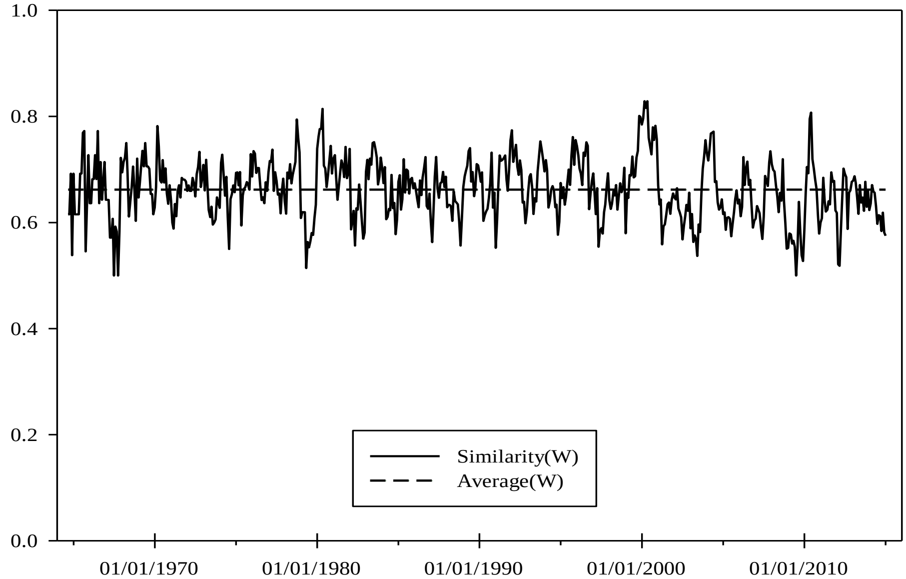
주요어: 전망이론, TK 모멘텀, 가격 모멘텀, 수익률 역전현상, 복권성향 주식

학번: 2014-20462

Figure 1. Portfolio Similarity between TK and JT

This figure describes the similarity between portfolios constructed by TK and JT winner/loser at each time *t*. Panel A represents a winner portfolio and Panel B represents a loser portfolio. Similarity between TK strategy and JT strategy is defined as the ratio of the number of stocks that are both in Short-term TK and JT winner (Panel A) or loser (Panel B) portfolios to the total number of stocks in any winner (Panel A) or loser (Panel B).

Panel A. Winner



Panel B. Loser

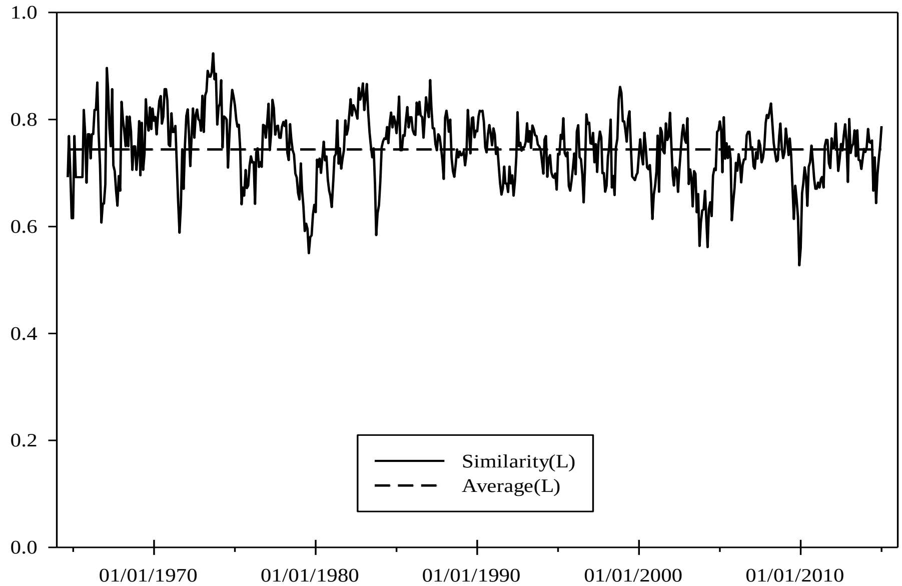
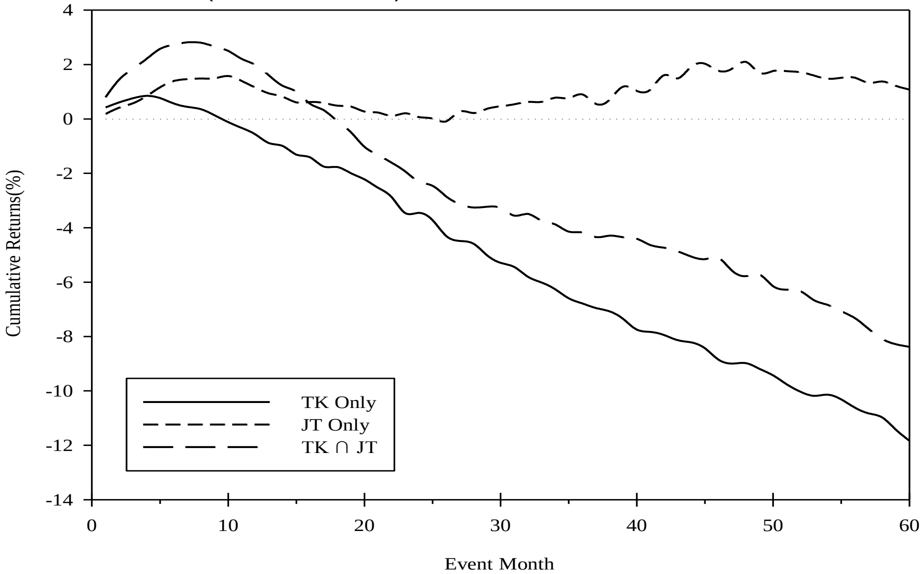


Figure 2. Cumulative Momentum Profits of Different Subset Strategies

This figure describes the cumulative momentum profits of different subsets over 60 months (from *t* to *t*+59) after the portfolio formation at the end of the month *t*-2. TK Only subset consists of stocks that are only in TK winner or TK loser. JT Only subset analogously consists of stocks that are only in JT winner or JT loser. Finally TK ∩ JT subset consists of stocks that are both in TK and JT winner/loser categories. Due to the small sample problem in TK Only and JT Only subsets, quintile rather than decile portfolios are formed to construct momentum strategies. Panel A is the case of full period (08/1964 ~ 12/2014) and Panel B is the case of sub period (08/1964 ~ 12/1999).

Panel A. Full Period (08/1964 ~ 12/2014)



Panel B. Sub Period (08/1964 ~ 12/1999)

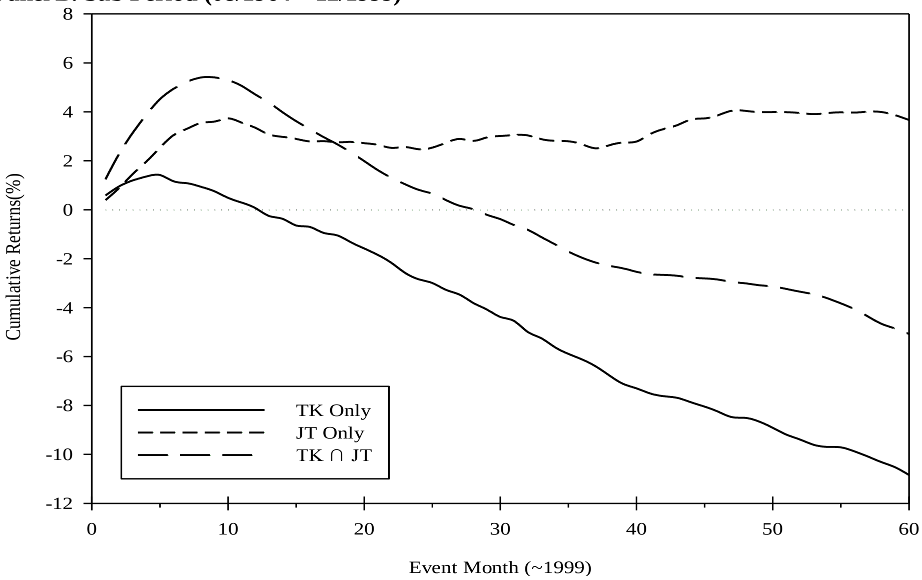
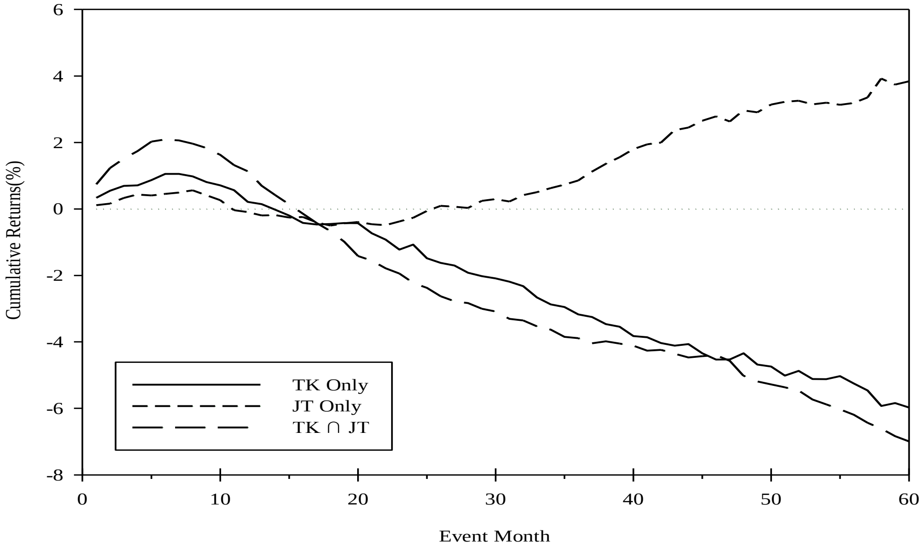


Figure 3. Cumulative Momentum Profits of Different Subset Strategies after Controlling Size

This figure describes the cumulative momentum profits of different subsets over 60 months (from *t* to *t*+59) after the portfolio formation at the end of the month *t*-2, during the full period. TK Only subset consists of stocks that are only in TK winner or TK loser. JT Only subset analogously consists of stocks that are only in JT winner or JT loser. Finally TK ∩ JT subset consists of stocks that are both in TK and JT winner/loser categories. To control the size effect, small and big size groups are divided by the median value of market capitalization. Due to the small sample problem, tercile rather than quintile portfolios are formed to construct momentum strategies. Panel A is the case of small size and Panel B is the case of big size. This is analyzed over the full period (08/1964 ~ 12/2014).

Panel A. Small Size



Panel B. Big Size

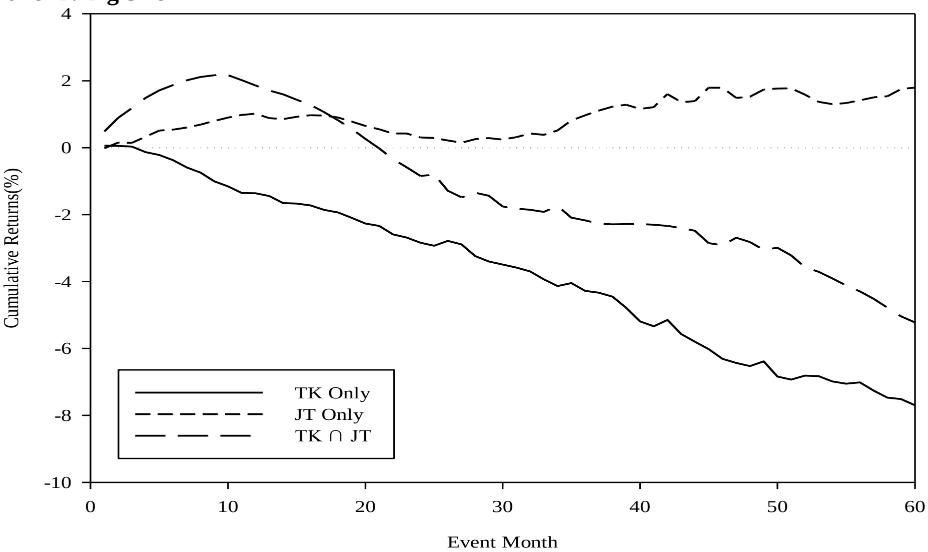


Figure 4. Cumulative TK Momentum Profits in Speed of Correction Quintile Portfolios

This figure describes the cumulative TK momentum profits in Speed1, Speed3, and Speed5 over the 60 months (from *t* to *t*+59) after the portfolio formation at the end of the month *t*-2. The variable Speed is computed by Hur and Singh (2014). Speed1, Speed3, and Speed 5 are the portfolios where each is the first, the third, and the fifth Speed quintile portfolio, respectively. Quintile portfolios are first formed by the ranks of the variable Speed at each time t. Then, in each quintile, I reconstruct winner and loser portfolios by making quintile portfolios based on Short-term TK to see TK momentum profits. This is analyzed over the full period (08/1964 ~ 12/2014).

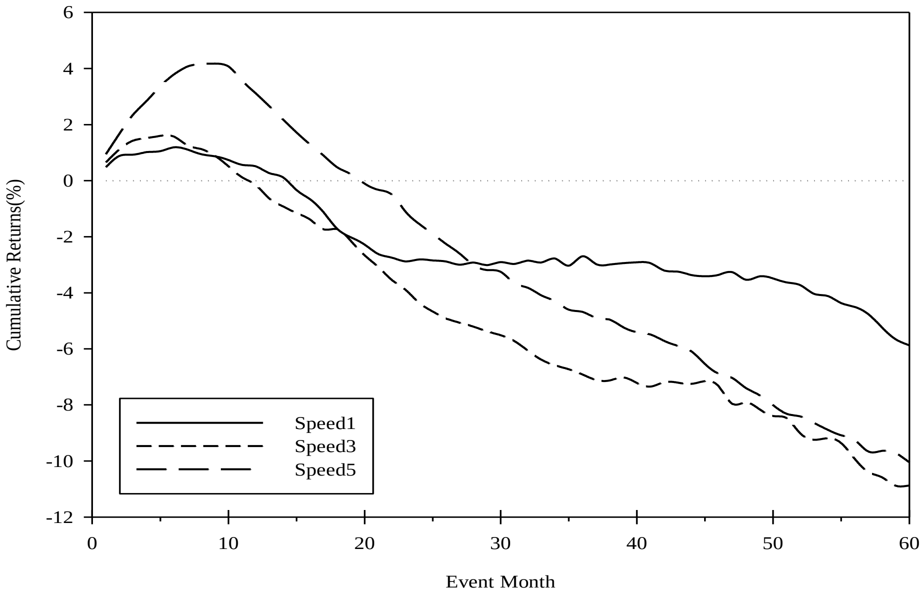


Figure 5. Holding Period Returns of Long-short Portfolios by Candidates of Lottery Proxy

This figure represents the holding period returns of long-short decile portfolios by candidates of lottery proxy over the 12 months (from *t* to *t*+12) after the portfolio formation at the end of the month *t*-1. Candidates of lottery proxy consist of Long-term TK, Extreme TK, MAX, and EISKEW. The analysis period is from 07/1969 to 12/2011.

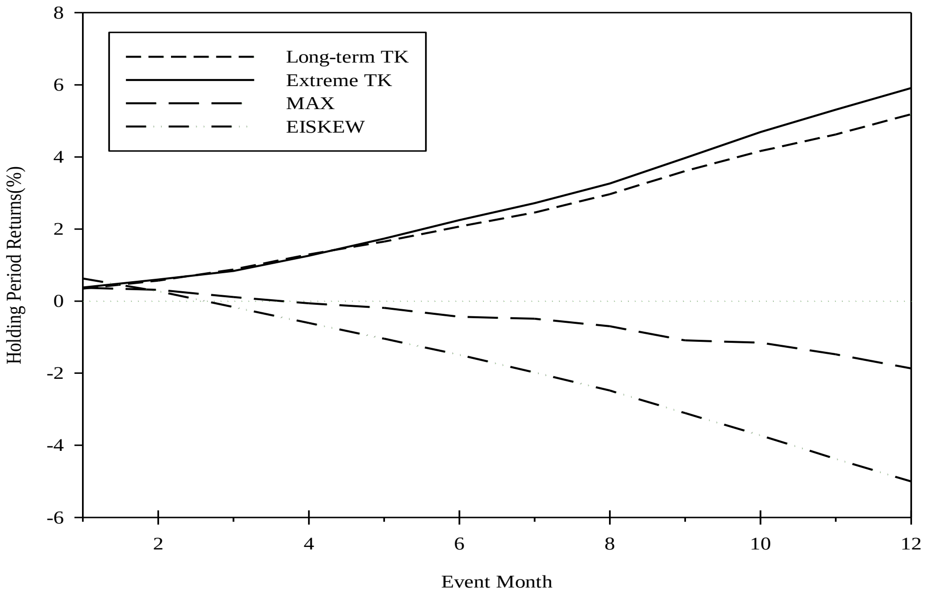


Table 1. Summary Statistics

This table shows the summary statistics of variables used in this paper. Panel A documents means, medians, maximums, minimums, and standard deviations, and Panel B documents correlations of the variables. All statistics are computed by monthly cross-section and reported by the time-series average of monthly cross-sectional statistics. Short-term TK (Long-term TK) at time *t* is the prospect theory value from the start of month *t*-13 (*t*-60) to the end of month *t*-2 (*t*-1), using monthly data. Extreme TK at time *t* is the prospect theory value by using 20 monthly returns with absolute values that are in the top 20 of the previous 60-month returns from *t*-60 to *t*-1. Size is the log market capitalization (unit: a thousand dollar) at the end of the previous month. BEME is the log book-to-market ratio following Fama and French (1992). JT at time *t* is the stock's cumulative return from the start of month *t*-13 to the end of month *t*-2. MAX is the maximum daily return during the previous 1 month following Bali et al. (2011). EISKEW is the expected idiosyncratic return skewness and is from Boyer et al. (2010). IVOL at time *t* is the idiosyncratic volatility over the previous 60 months from *t*-60 to *t*-1 using monthly data, as in Ang et al. (2006). ISKEW at time *t* is the idiosyncratic skewness over the previous 60 months from *t*-60 to *t*-1 using monthly data. Turnover at time *t* is the ratio of monthly trading volume to the number of shares outstanding at the end of month *t*. Speed at time *t* is the speed of price correction using the monthly data from *t*-13 to *t*-2 following Hur and Singh (2014).

Panel A. Statistics

	Short-term TK	Long-term TK	Extreme TK	Size	BEME	JT	MAX	EISKEW	IVOL	ISKEW	Turnover	Speed
Mean	-0.050	-0.053	-0.032	13.154	-0.572	0.200	0.051	0.808	9.210	0.399	9.400	-0.668
Median	-0.047	-0.052	-0.032	12.941	-0.500	0.164	0.042	0.753	8.464	0.322	6.353	-0.632
Max	0.222	0.117	0.158	18.475	2.009	2.750	0.583	2.735	48.137	4.985	233.701	-0.042
Min	-0.275	-0.153	-0.124	11.094	-4.388	-0.989	0.003	-0.608	2.885	-1.929	0.031	-1.761
Std. Dev.	0.052	0.026	0.025	1.394	0.695	0.357	0.039	0.406	4.036	0.636	12.108	0.288

(continued)

Table 1. Summary Statistics
Continued

Panel B. Correlations

	Short-term TK	Long-term TK	Extreme TK	Size	BEME	JT	MAX	EISKEW	IVOL	ISKEW	Turnover	Speed
Short-term TK	1											
Long-term TK	0.412	1										
Extreme TK	0.366	0.868	1									
Size	0.124	0.221	0.103	1								
BEME	0.059	-0.229	-0.248	-0.203	1							
JT	0.874	0.283	0.332	-0.025	0.001	1						
MAX	-0.129	-0.119	0.010	-0.233	-0.026	0.040	1					
EISKEW	-0.153	-0.116	-0.003	-0.371	0.037	-0.077	0.194	1				
IVOL	-0.107	-0.109	0.166	-0.420	-0.101	0.200	0.414	0.357	1			
ISKEW	0.104	0.308	0.460	-0.222	0.029	0.152	0.183	0.310	0.482	1		
Turnover	0.007	-0.039	0.042	-0.065	-0.109	0.183	0.232	-0.116	0.294	0.044	1	
Speed	-0.053	-0.022	-0.015	0.020	-0.013	-0.044	0.035	0.009	0.019	-0.012	0.033	1

Table 2. Monthly Returns of Momentum Strategies after the Portfolio Formation

This table represents the monthly returns of WML (winner – loser) portfolio after the portfolio formation at the end of month *t*-2. Specifically, Short-term TK and JT are computed using monthly returns from *t*-13 to *t*-2, and then monthly returns of TK WML and JT WML from *t* to *t*+11 are reported. Momentum strategy derived by each Short-term TK and JT is the long-short strategy that buys winner (the 10th decile) and shorts loser (the 1st decile). Not only full period (08/1964 ~ 12/2014) but also sub periods (08/1964 ~ 12/1999, 01/2000 ~ 12/2009, 01/2010 ~ 12/2014) are separately analyzed. All reported returns have a unit of percent (%), and the *t*-statistics are in the parentheses.

	t	*t*+1	*t*+2	*t*+3	*t*+4	*t*+5	*t*+6	*t*+7	*t*+8	*t*+9	*t*+10	*t*+11
						Full Period: 08/1964 ~ 12/2014						
TK WML	0.93	0.72	0.48	0.36	0.25	0.09	-0.02	-0.12	-0.23	-0.23	-0.36	-0.37
	(4.12)	(3.36)	(2.31)	(1.75)	(1.28)	(0.45)	(-0.09)	(-0.67)	(-1.29)	(-1.30)	(-2.02)	(-2.13)
JT WML	0.91	0.74	0.55	0.50	0.38	0.15	0.02	-0.05	-0.17	-0.18	-0.33	-0.34
	(3.73)	(3.19)	(2.44)	(2.25)	(1.79)	(0.77)	(0.10)	(-0.26)	(-0.92)	(-0.97)	(-1.79)	(-1.78)
						Sub Period: 08/1964 ~ 12/1999						
TK WML	1.44	1.12	0.89	0.75	0.60	0.36	0.21	0.07	-0.10	-0.20	-0.32	-0.41
	(6.53)	(5.15)	(4.23)	(3.54)	(2.89)	(1.81)	(1.09)	(0.37)	(-0.56)	(-1.07)	(-1.72)	(-2.20)
JT WML	1.40	1.20	1.04	0.87	0.79	0.50	0.33	0.18	-0.07	-0.11	-0.27	-0.45
	(5.76)	(5.14)	(4.33)	(3.73)	(3.49)	(2.31)	(1.54)	(0.87)	(-0.34)	(-0.53)	(-1.39)	(-2.20)
						Sub Period: 01/2000 ~ 12/2009						
TK WML	-0.84	-0.65	-1.05	-1.06	-1.12	-1.17	-1.17	-1.20	-1.08	-0.74	-0.81	-0.56
	(-1.07)	(-0.90)	(-1.54)	(-1.52)	(-1.77)	(-1.90)	(-2.03)	(-2.03)	(-1.90)	(-1.31)	(-1.47)	(-1.02)
JT WML	-0.88	-0.87	-1.18	-0.77	-1.04	-1.20	-1.31	-1.20	-1.08	-0.74	-0.76	-0.49
	(-1.05)	(-1.11)	(-1.64)	(-1.09)	(-1.59)	(-1.96)	(-2.24)	(-2.06)	(-1.93)	(-1.30)	(-1.38)	(-0.88)
						Sub Period: 01/2010 ~ 12/2014						
TK WML	0.86	0.64	0.57	0.46	0.57	0.67	0.75	0.79	0.69	0.70	0.42	0.41
	(2.24)	(1.77)	(1.51)	(1.30)	(1.68)	(1.87)	(2.13)	(2.26)	(1.99)	(1.98)	(1.20)	(1.25)
JT WML	1.01	0.65	0.61	0.34	0.29	0.45	0.56	0.72	1.03	0.50	0.26	0.90
	(2.53)	(1.56)	(1.51)	(0.90)	(0.77)	(1.11)	(1.45)	(1.74)	(1.94)	(1.27)	(0.69)	(1.32)

Table 3. Profits and FF5 Alpha of J/K Strategies for TK and JT Momentums

This table shows the profits from J/K strategies for the portfolios classified by Short-term TK or JT and for their WMLs. Also both profits and Fama-French 5-factor alphas by Fama and French (2015) of WML portfolios are reported. J/K strategy follows Jegadeesh and Titman (1993) and J=12/K=6 is used here. Monthly returns of J=12/K=6 strategy for the decile portfolios, WML portfolio, and January-excluded WML portfolio are computed using whole data set. Not only full period (08/1964 ~ 12/2014) but also sub periods (08/1964 ~ 12/1999, 01/2000 ~ 12/2009, 01/2010 ~ 12/2014) are separately analyzed. All reported returns have a unit of percent (%), and the *t*-statistics are in the parentheses.

	P1 (Loser)	P2	P3	P4	P5	P6	P7	P8	P9	P10 (Winner)	WML		WML (Jan. Excl.)	
											Raw Ret.	FF5 Alpha	Raw Ret.	FF5 Alpha
							Full Period: 08/1964 ~ 12/2014							
TK Strategy	1.01	1.09	1.10	1.19	1.16	1.17	1.22	1.24	1.32	1.49	0.48	0.78	0.71	0.99
											(2.43)	(3.98)	(3.51)	(4.86)
JT Strategy	0.98	1.10	1.13	1.13	1.15	1.14	1.20	1.26	1.37	1.52	0.54	0.86	0.71	1.07
											(2.54)	(4.25)	(3.21)	(5.09)
							Sub Period: 08/1964 ~ 12/1999							
TK Strategy	0.94	1.04	1.06	1.16	1.14	1.21	1.26	1.34	1.48	1.80	0.86	1.09	1.20	1.30
											(4.34)	(5.44)	(6.21)	(6.44)
JT Strategy	0.90	1.04	1.08	1.09	1.15	1.15	1.25	1.36	1.56	1.84	0.95	1.19	1.23	1.41
											(4.41)	(5.58)	(5.75)	(6.60)
							Sub Period: 01/2000 ~ 12/2009							
TK Strategy	1.30	1.18	1.11	1.15	1.03	0.89	0.93	0.77	0.65	0.40	-0.90	-0.63	-1.01	-0.38
											(-1.33)	(-0.96)	(-1.40)	(-0.56)
JT Strategy	1.29	1.23	1.16	1.12	1.02	0.92	0.91	0.79	0.59	0.38	-0.90	-0.40	-1.12	-0.23
											(-1.25)	(-0.61)	(-1.44)	(-0.33)
							Sub Period: 01/2010 ~ 12/2014							
TK Strategy	0.90	1.24	1.38	1.46	1.53	1.45	1.51	1.51	1.53	1.48	0.58	0.23	0.72	0.17
											(1.89)	(0.72)	(2.28)	(0.51)
JT Strategy	0.92	1.28	1.39	1.43	1.40	1.49	1.46	1.50	1.61	1.52	0.59	0.10	0.73	0.05
											(1.64)	(0.31)	(1.89)	(0.14)

Table 4. Momentum Profits of Different Subset Strategies

This table documents the momentum profits of J/K strategy from different subsets: TK Only, JT Only, and TK ∩ JT. TK Only subset consists of stocks that are only in TK winner or TK loser. JT Only subset analogously consists of stocks that are only in JT winner or JT loser. Finally TK ∩ JT subset consists of stocks that are both in TK and JT winner/loser. Due to the small sample problem in TK Only and JT Only subsets, quintile rather than decile portfolios are formed to construct momentum strategies. WMLs with whole data and with January-excluded data are reported. Not only full period (08/1964 ~ 12/2014) but also sub periods (08/1964 ~ 12/1999, 01/2010 ~ 12/2014) are separately analyzed. All reported returns have a unit of percent (%), and the *t*-statistics are in the parentheses.

	P1 (Loser)	P5 (Winner)	WML	WML (Jan. Excl.)
		Full Period: 08/1964 ~ 12/2014		
TK Only	1.13	1.23	0.10	0.34
	(3.98)	(6.79)	(0.66)	(2.17)
JT Only	1.12	1.35	0.23	0.22
	(5.51)	(4.66)	(1.18)	(1.11)
TK ∩ JT	1.02	1.48	0.46	0.63
	(3.81)	(5.56)	(2.48)	(3.32)
		Sub Period: 08/1964 ~ 12/1999		
TK Only	1.11	1.34	0.22	0.50
	(3.42)	(6.16)	(1.29)	(2.91)
JT Only	1.06	1.53	0.47	0.55
	(4.53)	(4.70)	(2.34)	(2.62)
TK ∩ JT	0.95	1.76	0.81	1.10
	(3.16)	(5.91)	(4.42)	(6.05)
		Sub Period: 01/2010 ~ 12/2014		
TK Only	1.21	1.47	0.25	0.46
	(1.60)	(2.58)	(0.77)	(1.44)
JT Only	1.36	1.64	0.28	0.34
	(2.80)	(1.97)	(0.67)	(0.75)
TK ∩ JT	1.01	1.53	0.52	0.64
	(1.54)	(1.99)	(1.78)	(2.11)

Table 5. Momentum Profits of Different Subset Strategies after Controlling Size

The momentum profits of J/K Strategy from different subsets from TK Only, JT Only, and TK ∩ JT are analyzed after size is controlled. TK Only subset consists of stocks that are only in TK winner or TK loser. JT Only subset analogously consists of stocks that are only in JT winner or JT loser. Finally TK ∩ JT subset consists of stocks that are both in TK and JT winner/loser. Panel A represents mean and standard deviation of size in each subset. Size is the log market capitalization (unit: a thousand dollar) at the end of the previous month. Each statistic is computed cross-sectionally in each month and then time-series average is reported. For Panel B and Panel C, size is divided into two groups: small size is below the median, and big size is above the median. Due to the small sample problem in TK Only and JT Only subsets, tercile rather than quintile portfolios are formed to construct momentum strategies. WMLs over the full analysis period and WMLs with January-excluded data are reported. All reported returns have a unit of percent (%), and the *t*-statistics are in the parentheses.

Panel A. Mean and Standard Deviation of Size

	Size	P1 (Loser)	P5 (Winner)
TK Only	Mean	12.53	13.77
	Std. Dev.	1.03	1.52
JT Only	Mean	13.42	12.65
	Std. Dev.	1.45	1.08
TK ∩ JT	Mean	12.79	13.04
	Std. Dev.	1.22	1.29

Panel B. Small Size

	P1 (Loser)	P3 (Winner)	WML	WML (Jan. Excl.)
TK Only	1.18	1.37	0.19	0.36
	(4.04)	(7.30)	(1.25)	(2.32)
JT Only	1.28	1.36	0.07	0.05
	(6.19)	(4.76)	(0.47)	(0.28)
TK ∩ JT	1.17	1.51	0.35	0.50
	(4.36)	(5.78)	(2.34)	(3.30)

Panel C. Big Size

	P1 (Loser)	P3 (Winner)	WML	WML (Jan. Excl.)
TK Only	1.08	1.03	-0.05	0.08
	(4.42)	(6.35)	(-0.40)	(0.58)
JT Only	1.01	1.09	0.09	0.04
	(5.90)	(4.55)	(0.58)	(0.27)
TK ∩ JT	0.93	1.25	0.32	0.43
	(4.12)	(5.56)	(2.00)	(2.62)

Table 6. Cross-sectional Comparison of TK and JT Momentum Strategies

The following cross-sectional regressions for each $j = 2, \cdots, 7$ due to the 6-month holding period are conducted to obtain coefficients each month.

$$R_{it} = b_{0jt} + b_{1jt}R_{i,t-1} + b_{2jt}Size_{i,t-1} + b_{3jt}TKW_{i,t-j} + b_{4jt}TKL_{i,t-j} + b_{5jt}JTW_{i,t-j} + b_{6jt}JTL_{i,t-j} + e_{it}$$

where $R_{i,t-1}$ and $Size_{i,t-1}$ are the return and the log market capitalization of stock i at time t-1. Other four variables are dummy variables such that $TKW_{i,t-j}$ has the value of 1 if the stock i is in the TK winner portfolio at time t-j. Other variables $TKL_{i,t-j}$, $JTW_{i,t-j}$, $JTL_{i,t-j}$ are analogously constructed corresponding to TK loser, JT winner, and JT loser, respectively. Each month, obtained coefficients for all six j's are averaged to represent the coefficients in the month. The reported coefficients for the raw returns are the time-series averages. For the case of risk-adjusted returns, Carhart 4-factor model from Carhart (1997) and Fama-French 5-factor model from Fama and French (2015) are used. The reported coefficients are alphas of time-series regressions using each coefficient's time-series data. Finally, $TKW - TKL$ and $JTW - JTL$ results are reported. The coefficients of *TKW-TKL* and *JTW-JTL* correspond to pure abnormal returns from TK momentum and JT momentum strategies, respectively. Not only full period (08/1964 ~ 12/2014) but also sub periods (08/1964 ~ 12/1999, 01/2010 ~ 12/2014) are separately analyzed. All reported returns have a unit of percent (%). The *t*-statistics are in the parentheses, and Newey and West (1987) corrected standard errors are used to get the *t*-statistics of raw returns case.

	Raw Returns		Risk-Adjusted Returns by FFC4-factor		Risk-Adjusted Returns by FF5-factor	
	Jan. Incl.	Jan. Excl.	Jan. Incl.	Jan. Excl.	Jan. Incl.	Jan. Excl.
			Full Period: 08/1964 ~ 12/2014			
Intercept	2.72	2.04	1.25	1.26	0.74	0.64
	(4.59)	(3.51)	(5.55)	(5.31)	(3.28)	(2.71)
$R_{i,t-1}$	-0.04	-0.03	-0.04	-0.03	-0.03	-0.02
	(-7.70)	(-6.46)	(-8.75)	(-7.22)	(-7.01)	(-5.55)
Size$_{i,t-1}$	-0.12	-0.07	-0.05	-0.05	-0.03	-0.02
	(-3.26)	(-2.03)	(-3.35)	(-2.99)	(-1.67)	(-1.00)
TK Winner Dummy	0.12	0.16	0.03	0.03	0.19	0.23
	(2.00)	(2.61)	(0.85)	(0.65)	(3.65)	(4.31)
TK Loser Dummy	-0.14	-0.24	-0.10	-0.15	-0.11	-0.19
	(-1.30)	(-2.17)	(-1.55)	(-2.23)	(-1.65)	(-2.59)
JT Winner Dummy	0.14	0.11	-0.02	-0.09	0.31	0.33
	(0.95)	(0.69)	(-0.30)	(-1.07)	(3.74)	(3.80)
JT Loser Dummy	-0.03	-0.07	0.13	0.15	-0.07	-0.11
	(-0.45)	(-0.94)	(2.65)	(3.04)	(-1.15)	(-1.65)
TK Winner Dummy - TK Loser Dummy	0.26	0.40	0.14	0.18	0.30	0.42
	(1.76)	(2.73)	(1.64)	(2.06)	(3.01)	(3.97)
JT Winner Dummy -JT Loser Dummy	0.17	0.18	-0.15	-0.24	0.38	0.44
	(0.86)	(0.84)	(-1.42)	(-2.21)	(2.99)	(3.31)

(continued)

Table 6. Cross-sectional Comparison of TK and JT Momentum Strategies
Continued

	Raw Returns		Risk-Adjusted Returns by FFC4-factor		Risk-Adjusted Returns by FF5-factor	
	Jan. Incl.	Jan. Excl.	Jan. Incl.	Jan. Excl.	Jan. Incl.	Jan. Excl.
			Sub Period: 08/1964 ~ 12/1999			
TK Winner Dummy - TK Loser Dummy	0.37	0.53	0.19	0.22	0.43	0.52
	(2.31)	(3.36)	(1.92)	(2.24)	(3.91)	(4.60)
JT Winner Dummy -JT Loser Dummy	0.40	0.48	-0.12	-0.10	0.50	0.58
	(1.97)	(2.29)	(-1.16)	(-0.95)	(3.65)	(4.21)
			Sub Period: 01/2010 ~ 12/2014			
TK Winner Dummy - TK Loser Dummy	0.23	0.39	0.29	0.32	0.22	0.28
	(1.15)	(1.67)	(1.59)	(1.63)	(1.05)	(1.30)
JT Winner Dummy -JT Loser Dummy	0.28	0.26	-0.26	-0.38	-0.09	-0.17
	(1.09)	(0.88)	(-1.22)	(-1.61)	(-0.41)	(-0.69)

Table 7. Bivariate Sort with Short-term TK and JT Momentum Strategies

This table represents the bivariate dependent sort analyses with TK and JT momentums. Particularly, the left side of the table shows TK WML results after JT is controlled; the right side of the table shows JT WML results after Short-term TK is controlled. In these analyses, 5×5 portfolios are formed. Not only full period (08/1964 ~ 12/2014) but also sub periods (08/1964 ~ 12/1999, 01/2010 ~ 12/2014) are separately analyzed. All reported returns have a unit of percent (%), and the *t*-statistics are in the parentheses.

Portfolios Classified by JT	Portfolios Classified by Short-term TK		TK Momentum		Portfolios Classified by Short-term TK	Portfolios Classified by JT		JT Momentum	
	P1 (Loser)	P5 (Winner)	WML	WML (Jan. Excl.)		P1 (Loser)	P5 (Winner)	WML	WML (Jan. Excl.)
Full Period: 08/1964 ~ 12/2014									
P1	0.95	1.14	0.19	0.39	P1	0.89	1.14	0.25	0.33
	(2.91)	(5.67)	(1.05)	(2.18)		(2.83)	(3.95)	(2.02)	(2.57)
P2	1.08	1.12	0.04	0.22	P2	1.10	1.19	0.09	0.03
	(4.10)	(6.71)	(0.32)	(1.56)		(5.38)	(4.44)	(0.62)	(0.17)
P3	1.10	1.12	0.02	0.19	P3	1.10	1.22	0.11	0.03
	(4.31)	(6.87)	(0.11)	(1.37)		(6.35)	(4.70)	(0.74)	(0.20)
P4	1.20	1.21	0.01	0.18	P4	1.09	1.38	0.29	0.21
	(4.55)	(6.72)	(0.08)	(1.42)		(6.81)	(5.06)	(1.63)	(1.12)
P5	1.34	1.51	0.17	0.24	P5	1.21	1.56	0.35	0.25
	(4.52)	(4.98)	(1.58)	(2.23)		(6.81)	(4.69)	(1.66)	(1.11)
Sub Period: 08/1964 ~ 12/1999									
P1	0.86	1.09	0.23	0.42	P1	0.81	1.14	0.33	0.43
	(2.37)	(4.69)	(1.19)	(2.13)		(2.36)	(3.45)	(2.47)	(3.22)
P2	1.05	1.11	0.06	0.25	P2	1.04	1.21	0.17	0.15
	(3.45)	(5.50)	(0.40)	(1.60)		(4.44)	(3.88)	(1.05)	(0.91)
P3	1.10	1.15	0.05	0.23	P3	1.06	1.31	0.25	0.21
	(3.71)	(5.81)	(0.33)	(1.49)		(5.16)	(4.40)	(1.46)	(1.19)
P4	1.26	1.32	0.06	0.25	P4	1.09	1.59	0.51	0.46
	(4.14)	(6.11)	(0.44)	(1.71)		(5.62)	(5.10)	(2.66)	(2.31)
P5	1.50	1.91	0.42	0.55	P5	1.30	1.98	0.67	0.62
	(4.50)	(5.71)	(3.52)	(4.67)		(6.10)	(5.33)	(2.98)	(2.62)
Sub Period: 01/2010 ~ 12/2014									
P1	0.68	1.45	0.77	0.92	P1	0.81	1.10	0.29	0.35
	(0.83)	(2.93)	(1.80)	(2.07)		(1.04)	(1.37)	(1.21)	(1.37)
P2	1.14	1.48	0.35	0.51	P2	1.40	1.41	0.01	0.01
	(1.55)	(3.32)	(0.91)	(1.35)		(2.81)	(1.77)	(0.02)	(0.02)
P3	1.29	1.52	0.23	0.36	P3	1.55	1.55	0.01	-0.06
	(1.78)	(3.16)	(0.70)	(1.07)		(3.36)	(1.92)	(0.01)	(-0.14)
P4	1.31	1.54	0.23	0.35	P4	1.47	1.42	-0.05	-0.11
	(1.68)	(2.62)	(0.80)	(1.23)		(3.22)	(1.71)	(-0.12)	(-0.22)
P5	1.72	1.26	-0.46	-0.48	P5	1.50	1.40	-0.10	-0.27
	(1.97)	(1.43)	(-1.60)	(-1.67)		(2.68)	(1.43)	(-0.21)	(-0.51)

Table 8. TK Momentum Profits after Controlling Speed of Price Correction

This table shows whether there is a tendency between the speed of price correction and TK momentum measured by J=12/K=6 strategy. The computation of the speed of price correction follows Hur and Singh (2014). All stocks are first classified by Speed quintile and then classified by Short-term TK quintile to generate TK momentum in each Speed quintile. Raw returns of all portfolios, WML, and WML with January-excluded are reported. All reported returns have a unit of percent (%), and the *t*-statistics are in the parentheses.

Portfolios Classified by Speed	Portfolios Classified by Short-term TK					TK Momentum	
	P1 (Loser)	P2	P3	P4	P5 (Winner)	WML	WML (Jan. Excl.)
P1	1.13	1.25	1.27	1.21	1.33	0.20	0.32
	(4.37)	(5.92)	(6.55)	(6.24)	(5.43)	(1.24)	(1.89)
P2	1.12	1.16	1.13	1.19	1.34	0.21	0.42
	(4.22)	(5.41)	(5.76)	(6.10)	(5.52)	(1.30)	(2.49)
P3	1.09	1.13	1.15	1.19	1.36	0.27	0.47
	(4.04)	(5.23)	(5.81)	(6.10)	(5.69)	(1.62)	(2.72)
P4	1.05	1.09	1.17	1.24	1.39	0.34	0.55
	(3.79)	(4.97)	(5.79)	(6.24)	(5.83)	(2.01)	(3.20)
P5	0.93	1.03	1.15	1.31	1.55	0.62	0.84
	(3.26)	(4.52)	(5.59)	(6.40)	(6.40)	(3.32)	(4.50)

Table 9. Extreme TK Justification and the Return Distribution of Candidates of Lottery Proxy

This table justifies the construction of Extreme TK and then represents decile portfolio returns by candidates of lottery proxy that are Long-term TK, Extreme TK, MAX, and EISKEW. #Extreme (n%) is introduced to justify the construction of Extreme TK. #Extreme (n%) is the number of monthly returns whose absolute values are greater than or equal to n%, over the previous 60 months. Panel A shows the monthly turnovers of decile portfolios by #Extreme (5%) and #Extreme (10%). Each turnover is denoted by Turnover (5%) and Turnover (10%), respectively. Panel B shows the returns of decile portfolios and long-short portfolios by candidates of lottery proxy. For the first three lottery candidates, the analysis period is 07/1968 to 12/2014, but the analysis period of EISKEW is 07/1969 to 12/2011. All reported returns have a unit of percent (%), and the *t*-statistics are in the parentheses.

Panel A. Monthly Turnovers of Decile Portfolios by #Extreme (n%)

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
Turnover (5%)	4.53	5.71	6.51	7.26	8.09	8.79	10.23	11.59	13.33	17.57	13.03
											(33.71)
Turnover (10%)	4.76	5.78	6.61	7.16	7.94	8.75	9.60	11.38	13.78	18.14	13.33
											(34.50)

Panel B. Raw Returns of Decile Portfolios by Candidates of Lottery Proxy

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P1-P10
Long-term TK	1.51	1.41	1.39	1.26	1.22	1.20	1.16	1.17	1.16	1.15	0.35
	(5.22)	(5.62)	(5.93)	(5.74)	(5.72)	(5.98)	(5.90)	(6.12)	(5.89)	(4.84)	(2.02)
Extreme TK	1.54	1.33	1.26	1.26	1.29	1.24	1.25	1.18	1.14	1.15	0.39
	(5.63)	(5.68)	(5.65)	(5.97)	(6.26)	(6.11)	(6.35)	(5.84)	(5.23)	(4.17)	(2.09)
MAX	1.24	1.29	1.34	1.35	1.31	1.37	1.38	1.34	1.19	0.81	0.43
	(8.02)	(7.29)	(7.07)	(6.65)	(6.09)	(6.07)	(5.80)	(5.21)	(4.33)	(2.74)	(2.06)
EISKEW	1.33	1.46	1.44	1.41	1.28	1.41	1.32	1.32	1.03	0.70	0.63
	(6.67)	(6.35)	(5.80)	(5.77)	(5.22)	(5.70)	(5.48)	(5.28)	(4.09)	(2.73)	(3.72)

Table 10. Lottery Characteristics

According to Kumar (2009), the lottery characteristics (price, IVOL, and ISKEW) are observed in each decile portfolios by each candidate of lottery proxy variable. Price of each stock at month *t* is the price at the end of month *t*-1. IVOL and ISKEW follows the definition stated in the Section 4. Not only decile portfolios but also long-short portfolios are analyzed. Panel A is for Long-term TK, Panel B is for Extreme TK, Panel C is for MAX, and Panel D is for EISKEW. For the first three Panels, the analysis period is 07/1968 to 12/2014, but the analysis period of Panel D is 07/1969 to 12/2011. The *t*-statistics are in the parentheses.

Panel A. Decile Portfolios Classified by Long-term TK

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
Long-term TK	-0.10	-0.08	-0.07	-0.06	-0.05	-0.05	-0.04	-0.04	-0.03	-0.01	0.09
											(146.19)
Price	14.35	18.33	21.50	24.71	27.14	30.03	33.01	36.11	39.06	41.58	27.23
											(55.46)
IVOL	11.74	10.42	9.68	9.12	8.61	8.22	7.86	7.69	7.93	10.85	-0.89
											(-9.76)
ISKEW	0.16	0.26	0.30	0.33	0.34	0.35	0.38	0.43	0.53	0.91	0.75
											(58.81)

Panel B. Decile Portfolios Classified by Extreme TK

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
Extreme TK	-0.07	-0.06	-0.05	-0.04	-0.03	-0.03	-0.02	-0.02	-0.01	0.01	0.09
											(122.60)
Price	16.56	20.88	24.28	26.29	28.77	30.72	32.67	34.82	35.85	34.96	18.40
											(40.34)
IVOL	10.50	9.38	8.87	8.49	8.21	8.12	8.06	8.34	9.16	12.99	2.50
											(21.82)
ISKEW	0.01	0.16	0.23	0.28	0.31	0.38	0.42	0.50	0.64	1.06	1.05
											(84.27)

(continued)

Table 10. Lottery Characteristics

Continued

Panel C. Decile Portfolios Classified by MAX

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
MAX	0.02	0.02	0.03	0.03	0.04	0.05	0.05	0.06	0.08	0.13	0.12
											(88.86)
Price	34.85	34.78	34.07	32.24	30.66	28.52	26.23	24.26	21.50	18.71	-16.15
											(-50.67)
IVOL	6.66	7.11	7.63	8.16	8.71	9.24	9.85	10.57	11.39	12.78	6.12
											(68.24)
ISKEW	0.30	0.28	0.30	0.33	0.35	0.38	0.42	0.46	0.52	0.66	0.36
											(48.39)

Panel D. Decile Portfolios Classified by Long-term EISKEW

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
EISKEW	0.19	0.41	0.54	0.63	0.71	0.81	0.91	1.05	1.25	1.57	1.38
											(55.66)
Price	32.97	33.40	33.23	33.96	32.79	29.97	25.63	21.10	17.51	13.79	-19.18
											(-43.46)
IVOL	7.13	8.22	8.46	8.39	8.49	8.91	9.40	10.38	10.82	12.03	4.90
											(62.89)
ISKEW	0.16	0.24	0.25	0.27	0.31	0.36	0.42	0.51	0.60	0.84	0.69
											(81.26)

Table 11. Bivariate Sort with Extreme TK and MAX or EISKEW

Table 11 shows bivariate sort analyses results with Extreme TK and MAX (or EISKEW). The left (right) side of Panel A shows the analysis by constructing quintile portfolios by Extreme TK (MAX) and then dividing each quintile portfolio into quintile portfolios by MAX (Extreme TK). Then, in each Extreme TK (MAX) quintile, the profit of long-short portfolio by MAX (Extreme TK) is reported. The same results using EISKEW instead of MAX are represented in Panel B. The analysis period is from 07/1969 to 12/2011. All reported returns have a unit of percent (%), and the *t*-statistics are in the parentheses.

Panel A. Extreme TK and MAX

Portfolios Classified by Extreme TK	Portfolios Classified by MAX			Portfolios Classified by MAX	Portfolios Classified by Extreme TK		
	P1	P5	P1-P5		P1	P5	P1-P5
P1	1.50	1.01	0.49	P1	1.36	1.33	0.04
	(6.80)	(3.38)	(2.96)		(6.74)	(7.71)	(0.33)
P2	1.27	0.99	0.28	P2	1.49	1.31	0.18
	(6.98)	(3.67)	(1.80)		(6.44)	(6.55)	(1.44)
P3	1.27	1.12	0.15	P3	1.63	1.27	0.36
	(7.54)	(4.37)	(0.90)		(6.50)	(5.36)	(2.46)
P4	1.19	1.04	0.15	P4	1.56	1.22	0.34
	(7.53)	(3.88)	(0.84)		(5.66)	(4.40)	(2.04)
P5	1.30	0.77	0.53	P5	1.23	0.85	0.38
	(7.20)	(2.28)	(2.21)		(3.95)	(2.45)	(1.68)

Panel B. Extreme TK and EISKEW

Portfolios Classified by Extreme TK	Portfolios Classified by EISKEW			Portfolios Classified by EISKEW	Portfolios Classified by Extreme TK		
	P1	P5	P1-P5		P1	P5	P1-P5
P1	1.76	0.83	0.93	P1	1.66	1.51	0.15
	(6.61)	(2.83)	(5.14)		(6.49)	(5.63)	(0.71)
P2	1.33	0.84	0.49	P2	1.69	1.43	0.26
	(6.01)	(3.37)	(3.04)		(5.85)	(5.19)	(1.49)
P3	1.32	0.95	0.37	P3	1.47	1.26	0.21
	(6.47)	(3.95)	(2.39)		(5.09)	(4.65)	(1.18)
P4	1.20	1.07	0.12	P4	1.50	1.14	0.36
	(5.94)	(4.60)	(0.79)		(5.24)	(4.36)	(2.11)
P5	1.46	0.63	0.83	P5	0.93	0.72	0.21
	(5.28)	(2.24)	(4.61)		(3.16)	(2.50)	(1.19)